37. The method of claim 26 wherein the steps are performed by a unit injector.

38. The method of claim 26 wherein the steps are performed in a number and sequence to produce an idle split injection with a combined volume of 15-20 cubic millimeters in about equal shots.

Abstract of the Disclosure

HYDRAULIC FUEL INJECTION SYSTEM WITH INDEPENDENTLY OPERABLE DIRECT CONTROL NEEDLE VALVE

A common rail fuel injection system addresses three basic issues involving all common rail fuel injection systems. These include high performance, low variability and high efficiency. These issues are addressed by combining pressure intensification with a three way needle control valve, which exhibits substantial leakage only during a brief instant when the valve is moving between seats. A quick acting needle control valve tightly coupled to a responsive direct control needle valve, as modified by relative timing with a flow control valve, can produce a wide variety of fuel injection rate shapes, including up to five or more discrete injections per engine cycle.